AD NUMBER

AD475268

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AUTHORITY

FTD, per USAF ltr, dtd 7 Oct 1971

FTD-TT-65-1177

AD 475268

TRANSLATION

DOCTORS IN INTERPLANETARY FLIGHTS

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UNEDITED ROUGH DRAFT TRANSLATION

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English pages: 13

SOURCE: Kridla Vlasti. (Czechoslovakian), No. 14, 1962, pp. 406-409.

Z/0003-062-000-014

TP5002470

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DOCTORS IN INTERPLANETARY FLIGHTS

by

Lubor Vokrouhlicky

In the introduction it is necessary to mention, that physiologists are not, in comparison with technology, by any way in the rear, as it would appear to a surface observer. Technical research must otherwise have a definite advantage; ans so for example, in the first period we had rockets without landing, later rockets with experimental animals, problems concerning the properties of the medium, to this already man himself had to penetrate. A majority of ground organisms require oxygen, heat, water and nutriments to live; all this occurs practically in the lowest atmospheric layer, which even offers protection against radiation. Biology which becomes the main requirement, cannot itself assure convenient physiological conditions in an interplanetary rocket; realization of these conditions depends upon the progress of technical sciences.

We will therefore discuss briefly the most important physiological problems of interplanetary flights, some of them have already been solved when modern aircraft began flying at high altitudes.

Providing The Crew of Interplanetary Rockets with Oxygen

Oxygen in the air is required by the human being because, that the blood in his lungs should oxidize and transfer same to the tissues which execute life. So that the blood should oxidize sufficiently, the oxygen in the air must be in definite volumetric quantity, must also have a definite pressure (about 100 mm Hg). All fliers know very well that at altitudes of about 5000 m it is necessary to use oxygen breathing, to increase the content (including also pressure)

of oxygen in the inhaled air, otherwise they would be threatened by fainting fits and later by death by nonoxidation of the brain. An oxygen breather helps up to a certain altitude; at an altitude of about 15 km, the barometric pressure is so low, that man could die then, if he would not have sufficient pure oxygen (the oxygen could not penetrate into the lungs, filled with carbon dioxide and water vapor. For flights at higher altitudes there is already needed a hermetically sealed superpressure chamber, into which the compressors maintain a higher barometric pressure than the pressure existing in the vicinity. The crew of an interplanetary rocket would have to be absolutely isolated in the cabin with artificial air, the proper equipment in the cabin will provide the proper amount of oxygen, warmth and air himidity, it eliminates carbon oxide, water vapor and fluids originating at living processes in the organism. And so, artificial climatic cabins have for example, so-called companion ships: the needed oxygen is obtained from bottles with compressed oxygen, carbon dioxide and water vapors are absorbed in sodium lye or by barnate (?), special filters (similar to filters in protective masks remove the harmful effects (harmful gases). Maintenance of warmth is technically easily soluble. In interplanetary space solar rays can serve (furnish) part of the heat, the solar rays will fall into the cabin. For long-lasting flights it is necessary to look for a different solution, because the mentioned system is too volumetric, heavy, and has an extremely limited capacity. The oxygen level in the cabin can be for example maintained in a much easier way by evaporation of liquid oxygen from special vessels. Carbon dioxide could be eliminated by freezing out, or decomposed by solar light, at which the oxygen would be liberated. (Cut this is only a theoretical solution, because as is known, in labs this process could not be realized to this day; during a reaction the latter threatens danger of forming dangerous formations of toxic-carbon oxide).

Recently intensive studies gave the possibility, which appears to be most convenient - use of vegetation, i. e., concrete defined sea weed, **alga**, which during its life processes uses up carbon dioxide and yields oxide. The difficulty lies in this that the hitherto developed equipment is spacious and the weight is unacceptable. The amount of oxygen needed by one person will now add suspension of alga in 230 liters of water, exposed to light over an area of 22 m^2; otherwise it is not known, how algas would react to ordinary circumstances. To solve these problems, contributions were also made by our own science; the biological law of the Czech Academy of Sciences is readying experiments with cerayin and other algaes.

Will the barometric pressure drop to perhaps 1/5 of the value, the gases dissolved in the blood plasma will become liberated (mainly nitrogen) in the form of bubbles, which fill up the brains and other cells thus making blood circulation impossible. This danger, which threatens at high altitudes, is almost totally eliminated by the cabin (isolation cabin).

Boili of liquids at the warmth of human body

In the mountains, where a lower barometric pressure prevails, water was cooked at no less than 100°C. Should the barometric pressure drop extremely under 50 mm Hg, the water cooks at 37°C, i. e., at a warmth of the human body. The interplanetary air empty space endangers then the health also by the fact, that in the unprotected organism body fluids will begin boiling; at a body heat water vapor bubbles would begin forming, filling out the body cavities and thus making the operation of the heart impossible. It is self-evident that an artificially maintained pressure of the special cabin will furnish good protection.

Effect of Solar Radiation

The wall of the cabin would protect the crew against the effects of ultraviolet components of solar radiation, we here on the ground are protected

against it by the terrestrial atmosphere. To increase the safety, it was proposed to fill up the space between the walls of the cabin covering with oxygen, which would, like in the atmosphere, form a protection against ultraviolet radiation. The solar spectrum will also include x-rays, which would however (since they are more penetrative than ultraviolet rays) sufficiently devour the structural material of the cabin.

We see then, that the definite problem of interplanetary journey is solved by a climatized cabin. Another complex of problems are formed by biological factors of interplanetary flight, which have not been sufficiently investigated, because they do not occur at high altitude flights and it is very difficult to form same experimentally. These are of course the next circumstances during long lasting interplanetary travels; and to meet human daily requirements (food, water, oxygen) is therefore almost unsoluble. The tempo of the technical progress is generally too rapid; many problems will enable one to solve flights with man-made satellites with human crews on board or more effective rocket driving matter, which would enable one to send out into the universe rockets with greater load.

Protection against cosmic radiation

Cosmic radiation penetrates into our atmosphere from distant spaces of the universe. These are actually atomic particles (protons and whole atomic nuclei of various elements - carbon, oxygen, nitrogen, magnesium, iron - electrons and gamma rays), they are provided with great energy, which will break the air atoms, will collide with them. The shattered air atoms are then the source of further radiation (so-called secondary, consisting of protons, neutrons, of particles, electrons and gamma radiation); normally this radiation is filtered by the high layer of the atmosphere and its intensity on the surface of the Earth is slight. At high altitudes atmospheric protection is

failing and intensity of cosmic radiation is rising rapidly. At altitudes of more than 20 km appears then only secondary radiation and the most dangerous particles of primary radiation (atomic nuclei of heavy elements).

Cosmic radiation causes ionization in the organism, which then results in disorders, material metabolism in the cells, disorder in cell membranes, depreciation of body albumina, origination of destructive tumors, etc. The tissues as a result of these changes die away. Result of a highly intensive investigation (here rockets were mainly applied with experimental animals) are nevertheless optimistic: secondary radiation was quite well studied over, and it was found, that it is not dangerous, even when its intensity rises rapidly at higher altitudes. It was ascertained about primary radiation, that its effects are not the same as before, prior to launching the first rockets, as it was judged; regeneration of tissues would therefore sufficiently recompense the dead cells. It is not always possible to cloak a series of unfavorable facts: some cells I nervous, cornea cells, lenses in the eye retina or cells in inner ear) are not regenerated; the time of exposure plays an important role. And so for example, in mice which were at an altitude of over 30 km (in a stratospheric balloon) they were exposed for 30 hours to solar radiation, their skins were sharply damaged, while at similar experiments signs of radiation were hardly found, only smaller illness signs. All this justifies a reserved conclusion.

Effects of long-lasting rectilinear acceleration

Effects of acceleration have been thoroughly investigated in aviation practice and on experimental installations, but its dangerous effect during long-lasting action was not too clear. The concept of "G" is very well known to our pilots and it is not necessary to explain its content in greater detail: unit G is acceleration imparted to the body by terrestrial gravitation (9.8 m/s^2).

For better comprehension, we can present the weight of a human body as a force, which affects the body and tries to impart to it an acceleration of one G. During rocket starting (straight line acceleration) forces originate much greater, which affect the organs of the body. Great organs take up in change of position certain conditions. But the blood concentrates in definite parts of the body (for example in the foot, in the head - according to the gravitation force) and can in this way affect important disorders. It depends here very much upon the rate of acceleration and in what direction it affects the body, and mainly on the fact, how long the acceleration lasts. For a short time the human organism will withstand great acceleration - for example up to 47 G for 1/4 of a minute - acceleration especially affects in the direction perpendicular to the longitudinal axis of the body (in the axis of chest and back) where the blood moves in the least and the large organs have a good support in the body. If acceleration does affect - seconds or finally minutes - the boundary endurance reduces rapidly, that is why the weight of the chest increases, which also reduces the breathing ability.

The experience obtained during the starting of rockets carrying satellite units with human crews, verifies to the fact, that the effects of acceleration will not be a hindrance to interplanetary flights (all cosmonauts endured an acceleration during the starting of carrier rockets, very well).

Effects of deceleration (negative G)

The effect of deceleration are similar, but the direction is reversed. It depends mostly on time and direction of affecting the body. The experimentally found and in practice partially checked values are favorable: and so for example, a human being can endure 20 G of negative acceleration over a period of 0.8 seconds (or 50 G in a diurnal period 0.4 sec).

High acceleration effects

Many people look curious at the assertion, that the velocity of a rocket has no damaging effect on the human organism: no realization is given to the fact, that great accelerations are actually moving (rate of rotation of the Earth at the equator: 1675 km/h, rate of movement of the Earth around the Sun: 100,000 km/hr). During symmetrical movement, regardless of how fast, only the center resistance may harm, the rocket cabin could protect against it during the landing of the interplanetary rocket (in air empty space the resistance of the medium is practically zero). A too great air resistance at lower altitudes - perhaps 6 ton per m^2 at a small velocity of 1000 km/hr - and great acceleration causes deadly wounding when leaving the cabin. This fact is the core of thh further problem.

Experiments with animals, which enabled the first flight of a cosmic ship with human crew on board, will be unavoidable also in the preparation for interplanetary flights.

Difficulty of protecting the crew

Various experiments, during experiments of Soviet scientists with dogs, successfully catapulted from a height of about 120 km, confirmed that the speed of the free fall from an altitude of perhaps 100 km, approaches at an altitude of 50 km a value of 1 km/sec, later on the drop is much slower. The originating accelerations are smaller, of about 4 G. It is necessary to prohibit the rolling of the falling body (it may suffer harmful physiological effects) and provide it therefore with high and low heats. At such a rapid descent the temperature also retains weak layers of thin air, around the falling body, values of about 2000° (with respect to very thin air, the thin air consisting of many parts will not transfer itself to the body); at an altitude of perhaps 30 km, low temperatures of the surrounding medium are affected.

About the possibilities of recovering from an interplanetary rocket, today's knowledge has unclear concepts. Perhaps it would be realizable with special equipment, like a "rocket in a rocket", in case of a small cosmic slide, which would tend toward the Earth.

Effects of weightless state

are not sufficiently well investigated. The man is in a habit of being ordinarily and constantly informed about the position of his body with respect to Earth by the sensual nervous elements (mainly in inner ear). In weightlessness state these elements will lose their cause, which will be comparable to disorientation, leading often to dizziness, discomfort and movements of nervo-muscular equilibrium (accuracy of the movement suffers).

The first brief experiments in proper flight condition in jet aircraft (weightless state lasted up to 40 sec), exactly like the first several hour flight in cosmic ships, appeared optimistic; but the second Soviet cosmonaut, G. S. Titov, who was exposed to the effects of weightlessness for a longer

GRAPHIC NOT
REPRODUCIBLE

Figure page 408 (top left) In a Cabin of a Satellite Ship

GRAPHIC NOT
REPRODUCIBLE

Figure, page 408 (bottom)...Basic Training of Crews for Interplanetary Flights will not Differ too much from cosmonaut Training

period of time - almost 25 hours - suffered definite difficulties. It is therefore impossible to speak with certainty, whether a long-lasting weightless state caused similar disturbances in all the persons or just in one, in

Figure, page 409 (top left)... In Special Vacuum Chambers, it is Easy to Create and is Approximately the same as Altitude of 200-399 km.
(top right) ... Reliability Examination Functions of a Special Cosmic Pressurization suit.

some persons there were observed highly sensual actions reacting in the static part of the organism. If it would be shown synonymously, that the duration of the weightlessness state has a disfavorable effect, it would be necessary to create in the cosmic ship cabins permanent artificial accelerations, which would compensate for the terrestrial gravitation. From the present status of technology this is very complex, but not an unsolvable problem.

The problem of reservation is a greater stone of injury. Interplanetary flights would last for months and years. The inevitable reserves, mainly water and food, would require such a large space and would weigh so much, that rockets of present day construction (driving engines on currently used propulsion media) could not lift it at all. And so it appears that the minimum need of 1.5 oxygen, 0.85 kg food and 2.6 kg of water per person per day, accidently still a lower number - a total of 4 kg of all reserves, as sufficient. And so,

we will not consider the great weight of the chemicals necessary for the absorption of carbon dioxide, with the weight of later needs, devices, etc - we will arrive at a number of 1.46 tons of supplies for one crew member a year.

Intensive investigations will nevertheless bring good fruit, as designated by studied possibilities of effectvie methods of providing crews with oxygen and water; we have already mentioned about this once. The selection of effective foods will be difficult, that is why it is debatable how the cosmonauts would endure long-lasting use of various extracts, for example foods extracted and prepared from algae

Psychic effects of interplanetary flights

In various considerations, published in popular press, these effects are generally totally disregarded, because they will play an important role. It is known that many pilots consider at altitudes of (about 20 km) a feeling of being "separated from the Earth", a feeling which is quite unpleasant. In an interplanetary rocket this condition actually appeared and could lead to a disturbance in spiritual activity. This is confirmed by the tests with persons well isolated from the surroundings. After a definite time they suffered disturbances in sensual and reasonable spiritual (irritability, madness, melancholy) which lasted for several weeks. Unfavorable would here be the change of the suffered rhythm of rotation of day and night, the main orientation sense of the human being in space - vision - would be removed to the rear and so on. Crews of future interplanetary rockets (provided with all the devices, which would enable constant contact with the Earth) will have to be even more carefully selected than the present day cosmonauts.

Protection against meteorites

is an exclusive technical problem. The striking of the cabin would directly or indirectly (loss of artificial medium) threaten the crew. On the basis of

information obtained from skillful satellites, considers therefore the encounter with meteorites of various sizes. Conclusions are favorable: the probability of colliding with more meteorites is slight at higher altitudes. And so for example, to express the probability of collision with meteorites weighing 0.5 g (which would destroy even an 8 cm layer of aluminum) at an altitude of over 100 km within 24 hours in propotion to 1:32 millions. But it is necessary to take into consideration that skillful satellites will gain partial protection from the atmosphere (it can be even very thin, sice it moves in it). And when the density of air at high altitudes, for example at an altitude of 200 km, of the order of 10 million series lower than at the surface of the Earth, a greater part of the meteorites does no longer penetrate there. In the solar area are nevertheless definite place, in them occur regularly meteorite currents; protection against them will be first of all careful navigation in flight preparation, assuring that the rocket will avoid these areas. When flying beyond the boundaries circular to the path of Mars road, the cosmonauts would be endangered by a more important danger- possibility of coming in contact with small planets (these planets are a combination of perhaps 1600 small celestial bodies; the smallest of a dimension of almost 1 km); collision with any one of the small planets would be a catastrophy.

As protection against large meteorites and small planets, suggests to technicians various protections (e. g., automatic radio location "deviator" of rocket, automatic destruction of meteorite with various rocket shots, etc.), their effectiveness is quite problematic.

And a conclusion? Up until recently the fantastic/longing of people, to visit the neighboring celestial bodies, can be soon be realised. Technical and biological research will broaden the ways and will make clear the hitherto unclear problem. Some Soviet researchers think, that to the end of this Century man will visit all the nearest planets.

GRAPHIC NOT REPRODUCIBLE

Figure, page 409 (bottom)... The Cabin of the Cosmic Ship will Fall out, and from it will Land the First People on the Moon or on the Mars? A Problem to which there is no Answer so far.